New Specification

Rewarding Learning

Centre Number

71

Candidate Number

General Certificate of Secondary Education
2011

Technology and Design

Unit 2:
Systems and Control

Element 1: Electronic and Microelectronic Control Systems

[GTD21]

GTD21

MONDAY 6 JUNE, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Answer **all** questions.
On **page 3** we have provided formulae for you to use with this paper.
Questions for this paper begin on **page 4**.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

For Examiner's use only	
Question Number	**Marks**
1	
2	
Total Marks	

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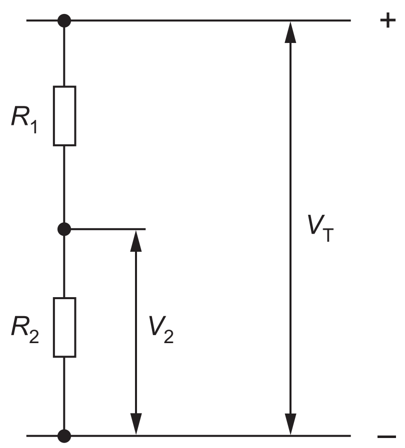
Formulae for GCSE Technology and Design

You should use, where appropriate, the formulae given below when answering questions which include calculations.

1 Potential Difference = current × resistance ($V = I \times R$)

2 For potential divider

$$V_2 = \frac{R_2}{R_1 + R_2} \times V_T$$



3 Series Resistors $R_T = R_1 + R_2 + R_3$ etc.

Parallel Resistors $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$

4 Time Constant T = R × C

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Marks	Remark

Element 1

Electronic and Microelectronic Control Systems

Answer **all** questions.

1 **(a)** Complete the following statements by inserting the missing word:

In an electronic circuit current is a flow of charge carried by

______________________________ [1]

The unit used to measure electrical current is

______________________________ [1]

In an electronic circuit the force which produces a flow of charge is

known as ______________________________ [1]

The unit used to measure electrical resistance is

______________________________ [1]

(b) Two resistors are shown in **Fig. 1** and **Fig. 2** below. Each resistor has four coloured bands, the fourth band is off-set from the other three bands.

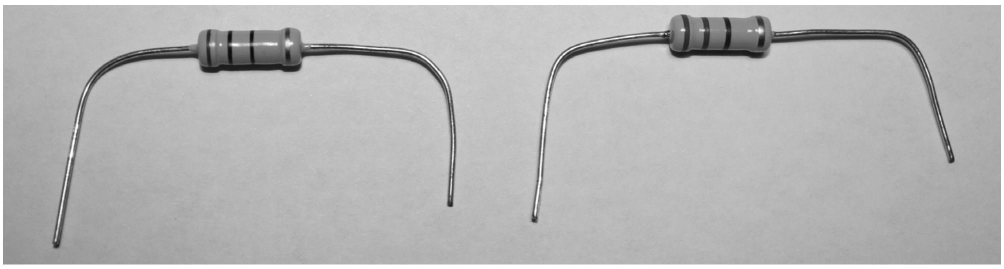

Fig. 1 (47 kΩ) **Fig. 2 (2.2 kΩ)**

(i) State the value of each resistor in **Ω**s.

47 kΩ = ______________**Ω** 2.2 kΩ = ______________**Ω** [2]

(ii) Use the information below to identify the colours of the first three bands for the resistor in **Fig. 1**.

0 = Black	1 = Brown	2 = Red	3 = Orange	4 = Yellow
5 = Green	6 = Blue	7 = Violet	8 = Grey	9 = White

Band 1 __________ Band 2 __________ Band 3 __________ [3]

(c) (i) If, in **Fig. 1**, the fourth band is coloured silver (10%) and in **Fig. 2** the fourth band is coloured gold (5%), use notes and calculations to show the information that can be obtained for each resistor.

Fig. 1 notes ____

____

Fig. 1 calculations

Fig. 2 notes ____

____

Fig. 2 calculations

[6]

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Marks	Remark

(ii) If the two resistors illustrated in part **(b)** are used in a potential divider circuit as shown in **Fig. 3** calculate the expected output at X.
Set out your calculations in the space shown.

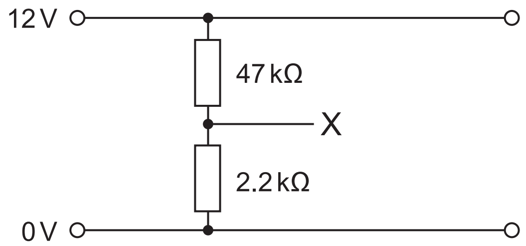

Fig. 3

Calculations

Output at X = ______________________ [5]

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Marks	Remark

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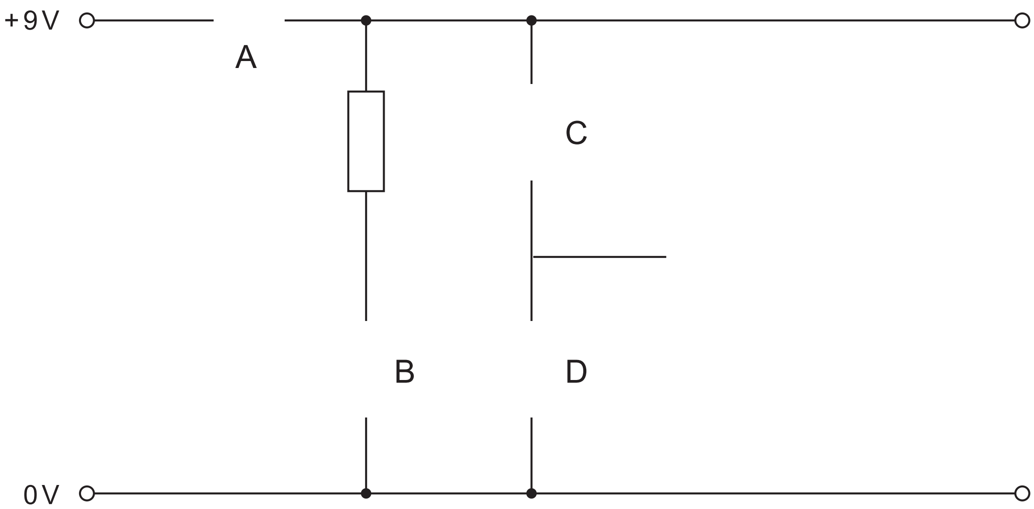
Marks	Remark

(d) **Fig. 4** shows a basic circuit layout that requires the components shown in Table 1 to be located in **Fig. 4** as follows:

Table 1

Location	Component
A	SPST
B	LED
C	Variable Resistor
D	Polarised Capacitor

(i) Insert each component symbol in the correct place in **Fig. 4**.



[4]

Fig. 4

The circuit in **Fig. 4** is required to operate a relay when a transistor is switched on.

(ii) Complete the circuit in **Fig. 4** by including the relay and transistor.
Include any additional components that are needed for this circuit. [4]

[Turn over

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(iii) Outline the purpose of any additional components that you have used when completing **(d)** part **(ii)**.

____

____

____

____ [2]

(iv) Describe the operation of the completed circuit stating the function of **each** component.

____

____

____

____

____

____

____ [8]

(v) Suggest **one** possible use for this circuit

Use ____

____ [2]

2 A typical alarm system uses bits and bit patterns as the method of communication. For example, the plan in **Fig. 5** shows doors and windows either closed or open. If a door or window is open it is represented as a "1" and if it is closed it is represented as a "0". Each door or window is identified by a letter.

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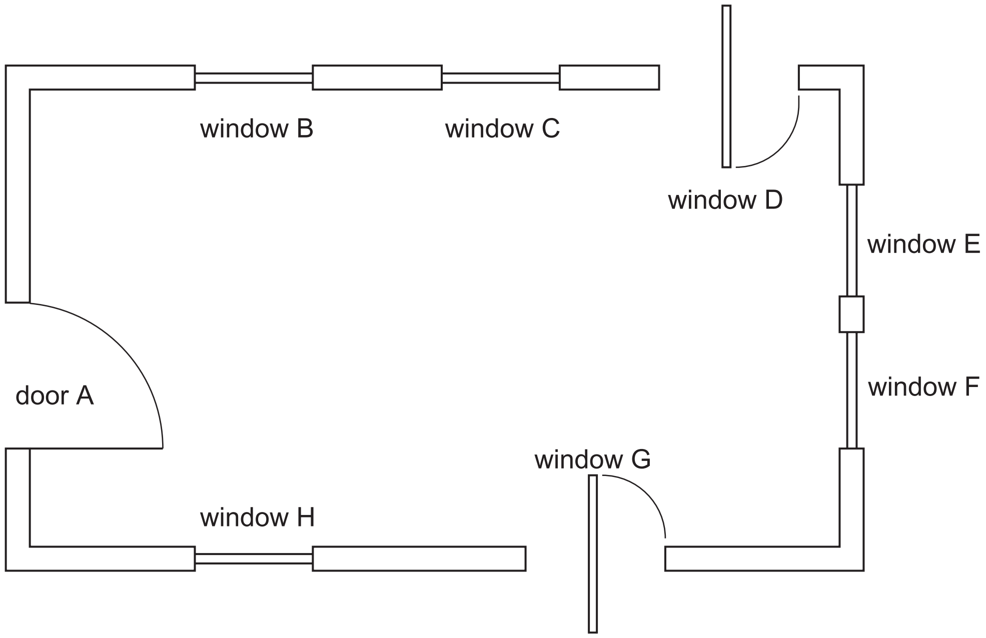

Fig. 5

(a) (i) Complete the bit pattern below to represent the position of the doors and windows in **Fig. 5**. [3]

Window and Door Bit Pattern

A	B	C	D	E	F	G	H
	0	0	1	0	0		

(ii) Outline **two** features of a microcontroller (PIC).

____

____

____ [2]

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Marks	Remark

(iii) List **two** advantages of using a microcontroller compared to an integrated circuit such as a 555 timer.

____ [4]

(iv) List **three** applications, other than an alarm system that use a microcontroller.

____ [3]

(b) To maintain climate control in a greenhouse a window is opened and closed using a motor operated by a microcontroller. The window opens when a temperature sensor rises to 25°C and closes when the temperature falls below 20°C. **Fig. 6** shows the cross-section of the window including two limit switches and temperature sensor.

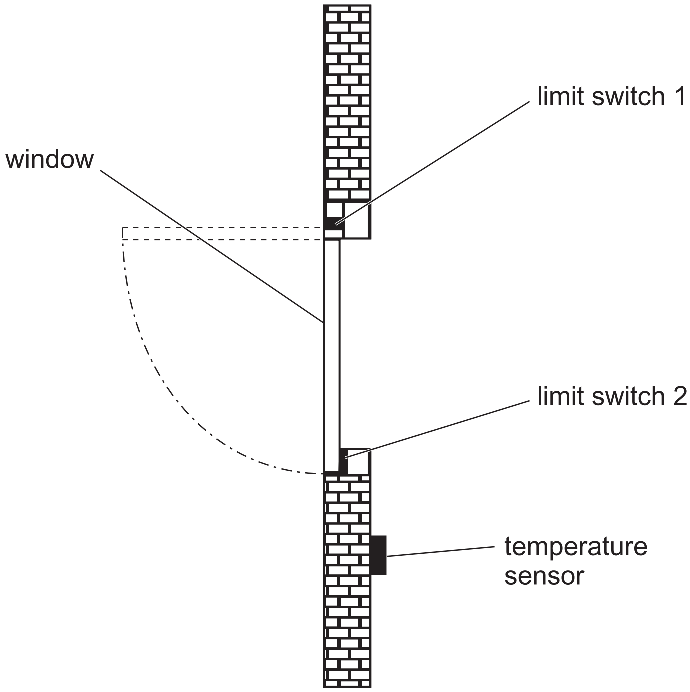

Fig. 6

The PIC has 5 inputs (only 3 are used) and 8 outputs (only 4 are used).

A binary "1" indicates that a switch has been pressed or that the temperature sensor has risen to the set temperature.

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Marks	Remark

The input connections are as shown in Table 2.

Table 2

PIC Inputs	(Not used)	Limit switch 2	Limit switch 1	(Not used)	Temperature sensor
BIT	4	3	2	1	0

The output connections are as shown in Table 3.

Table 3

PIC Outputs	(Not used)	(Not used)	Motor		(Not used)	(Not used)	LED	Buzzer
BIT	7	6	5	4	3	2	1	0
Motor clockwise	X	X	0	1	X	X	X	X
Motor anti-clockwise	X	X	1	0	X	X	X	X
Motor Off	X	X	0	0	X	X	X	X

Two bits are required to control the motor. An "X" means ignore.

A binary "I" switches the LED or buzzer on.

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Marks	Remark

Construct a series of flowcharts to represent the overall operating routine as follows:

(i) Complete a flowchart and its relevant bit pattern in **Fig. 7** to represent the OPEN macro as follows:
- Motor rotates clockwise to open the window
- The motor is turned off when limit switch 1 is activated
- The macro ends [8]

	OPEN			**BIT PATTERN**

Fig. 7

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Marks	Remark

(ii) Complete a flowchart and its relevant bit pattern in **Fig. 8** to represent the CLOSED macro as follows:

- Motor rotates anti-clockwise to close the door
- The motor is turned off when limit switch 2 is activated
- The macro ends

[8]

	CLOSED			**BIT PATTERN**

Fig. 8

Examiner Only	
Marks	Remark

(iii) The system is to be modified by introducing a LED and buzzer to warn that the window is about to open. Using the OPEN and CLOSED macros produced in parts **(i)** and **(ii)**, complete a flowchart in **Fig. 9** to operate the system as follows:

When the temperature sensor reaches a temperature of 25°C the LED and buzzer will come on for 3 seconds. The OPEN macro operates and then waits until the temperature drops to 20°C before the window closes using the CLOSED macro. The system will repeat.

Beside each input and output cell, indicate the relevant bit pattern.

No bit pattern is required for the macros. [12]

	START ↓			**BIT PATTERN**

Fig. 9

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Marks	Remark

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